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50. Internationales Wissenschaftliches Kolloquium
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Improving of Resolver Performance

ABSTRACT

The paper offers the method of increasing of accuracy of motion system with resolver by calibration. During calibration, the position data *R* from resolver are evaluated by precision optical encoder *P*.

A resolver is an electromechanical transducer that converts shaft angle to the sine-cosine analog signals. Resolver is very robust against action of dust, oil, temperature, shock and vibrations. But resolver position data is not very precise: angular accuracies are in range from 1 ... 5 arc-minutes with traditional arctangent data conversion algorithm. Fig 1. presents the 2 arc-minuters precision resolver error measured for four periods of resolver signal.

One of the methods of improving the resolver accuracy is to calibrate the resolver using precision optical encoder.

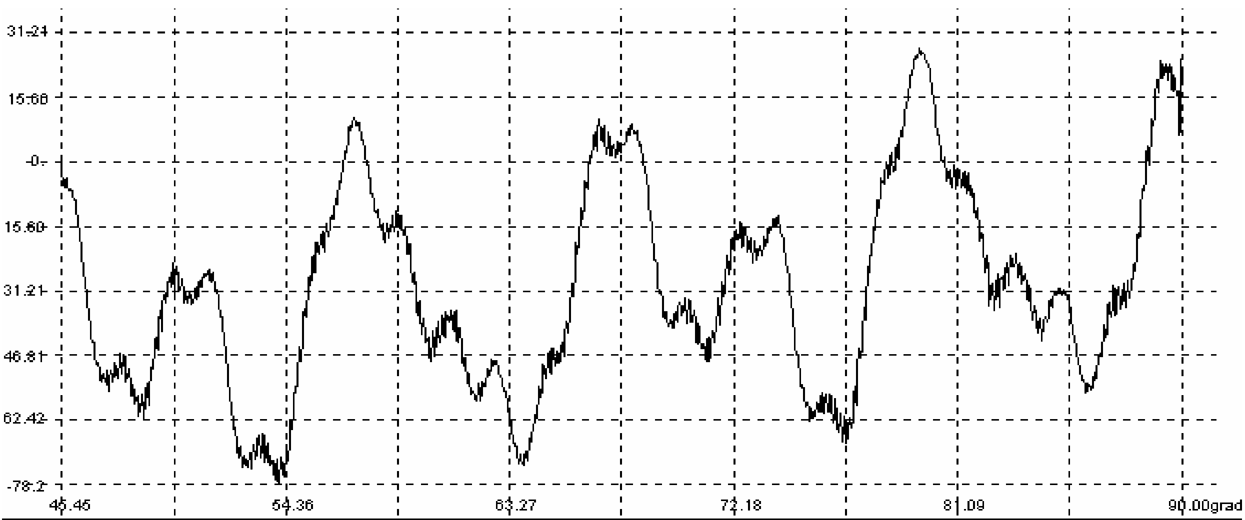

Fig. 1 The resolver error before calibration, $X - \theta_R$ (mech. deg), $Y - e(\theta_R)$ (arc-seconds)

Let be the θ_R – the mechanical position measured by resolver *R*; $\theta_P(\theta_R)$ – the mechanical position measured by optical encoder *P* at the same time as θ_R. The result of calibration is $\widehat{e}(\theta_R)$, where

$$e(\theta_R) = \theta_P(\theta_R) - \theta_R,$$
$$\hat{e}(\theta_R) \text{ is estimation of } e(\theta_R) \tag{1}$$

Choose of estimation $\hat{e}(\theta_R)$ is determined by two factors. It must allow compact storage in motion controller memory and fast calculation of particular value during motion control. DSP-based motion controllers allow the use of Fourier transform for estimation. So after resolver calibration the Fourier transform of $e(\theta_R)$ is fulfilled:

$$a_k = \frac{1}{\pi}\int_{-\pi}^{\pi} e(\theta_R)\cdot cos(k\cdot\theta_R)d\theta_R,\ b_k = \frac{1}{\pi}\int_{-\pi}^{\pi} e(\theta_R)\cdot sin(k\cdot\theta_R)d\theta_R \tag{2}$$
$$k = k_1,\ldots,k_n$$
$$\hat{e}(\theta_R) = \frac{a_0}{2} + \sum_{n=1}^{N}\left(a_{k_n}\, cos(k_n\cdot\theta_R) + b_{k_n}\, sin(k_n\cdot\theta_R)\right) \tag{3}$$

$k_1,\ldots,k_n$ are choosed so that

$$|e(\theta_R) - \hat{e}(\theta_R)| + e_P \le e_R \tag{4}$$

The paper describes the method of calculation of $\hat{e}(\theta_R)$ depending on e_P – maximal error of P and e_R – the desired maximal error of R; $e_R > e_p$. During the motion control, the estimation of motor $\hat{\theta}$ position is calculated according to equation:

$$\hat{\theta} = \theta_R + \hat{e}(\theta_R), \tag{5}$$

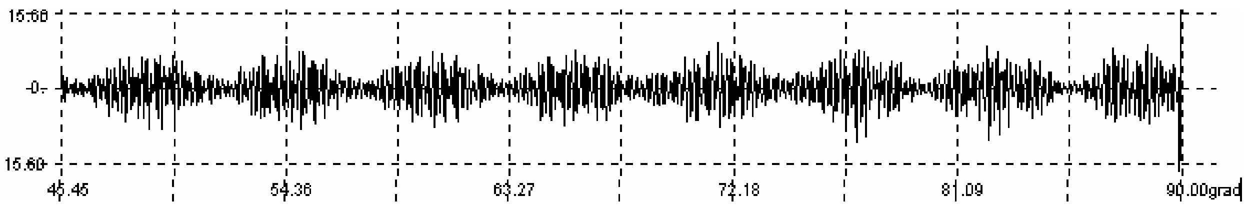

Fig. 2 The resolver error after calibration, X – θ_R (mech. deg), Y – $e(\theta_R)$ (arc-seconds)

Fig 2. presents the same resolver as from Fig. 1 error if the position is computed according to (5) with off-line computed error $\hat{e}(\theta_R)$ estimation.

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